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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

INTERIM REPORT ON MODEL STUDY OF COACHELLA PROTECTIVE WORKS ALL-AMERICAN CANAL

Hydraulic Laboratory Report No. 204

ENGINEERING AND GEOLOGICAL
CONTROL AND RESEARCH DIVISION

BRANCH OF DESIGN AND CONSTRUCTION
DENVER, COLORADO

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Branch of Design and Construction
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and Research Division
Denver, Colorado
May 14, 1946

Laboratory Report No. 204
Hydraulic Laboratory
Compiled by: D. J. Hebert

Subject: Interim report on model study of Coachella Protective Works - All-American Canal.

Pursuant to a request contained in a memorandum to Mr. Blanks through the Assistant Chief Designing Engineer from H. G. Curtis dated March 30, 1945, a hydraulic model of Detention Basin No. 1 of the Coachella Protective Works was built and tested.

The principal questions for which answers were sought were first, will there be any tendency for the flood to overtop the dike during dispersal in the basin and secondly, what are the magnitudes of the maximum velocities in the constricted sections. An analytical study of these problems is presented in a memorandum to H. G. Curtis from E. H. Larson, dated May 17, 1945. The results of this study were very helpful in the planning and execution of the model study. The nomenclature used by Mr. Larson is followed in this memorandum.

Due to limitations of laboratory space it was necessary to adopt a large distortion in the model scales. Three different linear scales were used; 1 to 1,200 for length, 1 to 750 for width, and 1 to 20 for depth. The kinematic scale relations resulting from these geometric ratios are: velocity, 1 to $\sqrt{20}$ or 1 to 4,472; time, 1 to 268.33; discharge, 1 to 67,080. A photograph of the model is shown in figure 1. The large time ratio of 1 to 268.33, or 1-hour prototype corresponds to 13.4 seconds model, made it necessary to develop special equipment to measure the rapid change in depth as the flood disperses in the detention basin. This development work required a great deal of time which delayed testing of the model. A photograph of the electronic equipment developed for depth measurement is shown in figure 2.

The flood in the model was created by a machine which consisted of a crest and a vane actuated by a motor-driven cam. The motor-driven cam forced the vane to move in such a way that the flow over the crest was divided in just the proper proportion that the flow into the model represented the predicted flood. The flood machine duplicated only the first 10 hours of the prototype flood because only this portion was significant. Details of the machine are shown in figure 3.

The testing program consisted of making records of variations in depth at ten (10) stations along the basin as well as records of velocity variations at the two most critical sections for two different model conditions.

The distortion in model scales required that the model roughness be adjusted to offset the slope distortion. In order to obtain a roughness adjustment which would give the proper channel resistance at every depth prototype measurements would be required. Since no data was available for use as a basis for adjustment the following expedient was adopted. Two different model conditions, that is the model with two entirely different channel resistances, were tested and compared. In the first condition, the model resistance in the uniform sections corresponded to a Manning "n" of 0.012. In the second condition, the model channel resistance was increased to correspond with a Manning "n" of 0.060. Considerations of similitude indicated that a model resistance or value of Manning "n" of the order of 0.060 to 0.100 depending upon the channel shape would be required to represent the value of 0.030 estimated for the prototype. However, it would be unnecessary to refine the adjustment of model roughness if the change from a value of "n" from 0.010 to 0.060 did not alter the general conclusions which might be drawn from the model data.

The variation in depth in the pool adjacent to Shavers Canyon for both model conditions, that is with and without artificial roughness, is shown in figure 4. The depth in this pool is the most critical of all the pools with respect to the possibility of overtopping the dike. Lack of time and personnel made it impossible to extract more of the data from oscilliograph records at the present time. However, the variation shown in figure 3 indicated quite clearly that there will be no overtopping of the dike. The effect of adding roughness is to increase the depth in the pool in the early portion of the flood by about 1-1/2 feet. Even with the larger roughness the depth increases continuously to a maximum corresponding to the steady level where the channel storage equals the volume of the flood. No temporary depth in excess of the final depth occurred.

Measurements of velocity were made at the two most critical sections which are indicated in figure 1. Two midget current meters were available although they were of different makes. One, built at the Iowa Hydraulic Institute, was used at section A and the other, built by Leupold and Stevens, was used at section B. The velocities at each section for both model conditions are shown in figure 5. The maximum velocity of 16 feet per second occurred at section A for the condition of no roughness. With roughness in place the maximum velocity was reduced to 10.5 feet per second and it occurred at the same time in the flood cycle. The velocity curve at section B for no roughness reached a maximum of 8.5 feet per second with roughness. The irregularity in the curve for no roughness was probably due to a mementary reduction in velocity when the initial wave reflected from the end of the basin reached this section. With roughness in place the attenuation of this reflected wave was enough to offset it. The maximum velocities are well below the values of 12.8 and 8.3 feet per second estimated in the computations of E. H. Larson in his memorandum to you under date of May 17, 1945.

Velocities were not measured directly in the constricted reach between ponds 2 and 1 because the section was too small for even a midget current meter. However, the velocity may be computed approximately from the records of depth. A cursory examination of the records of depth indicates that critical flow prevailed up to a depth of 3.5 feet. The critical velocity corresponding to this depth would be 8.7 feet per second. It was indicated by the measurements at sections A and B that the actual velocity is somewhat less than that corresponding to critical flow for steady conditions. Part of the upstream depth is probably required for accelerating the flow at the section. It is estimated that if the velocity had been measured a maximum velocity no greater then 8.0 feet per second would have been obtained.

A detailed report including a complete analysis of the oscillograph records will be made as soon as time permits. A comparison of the model results herein presented shows a qualitative agreement with the results of Mr. Larson's analytical study.

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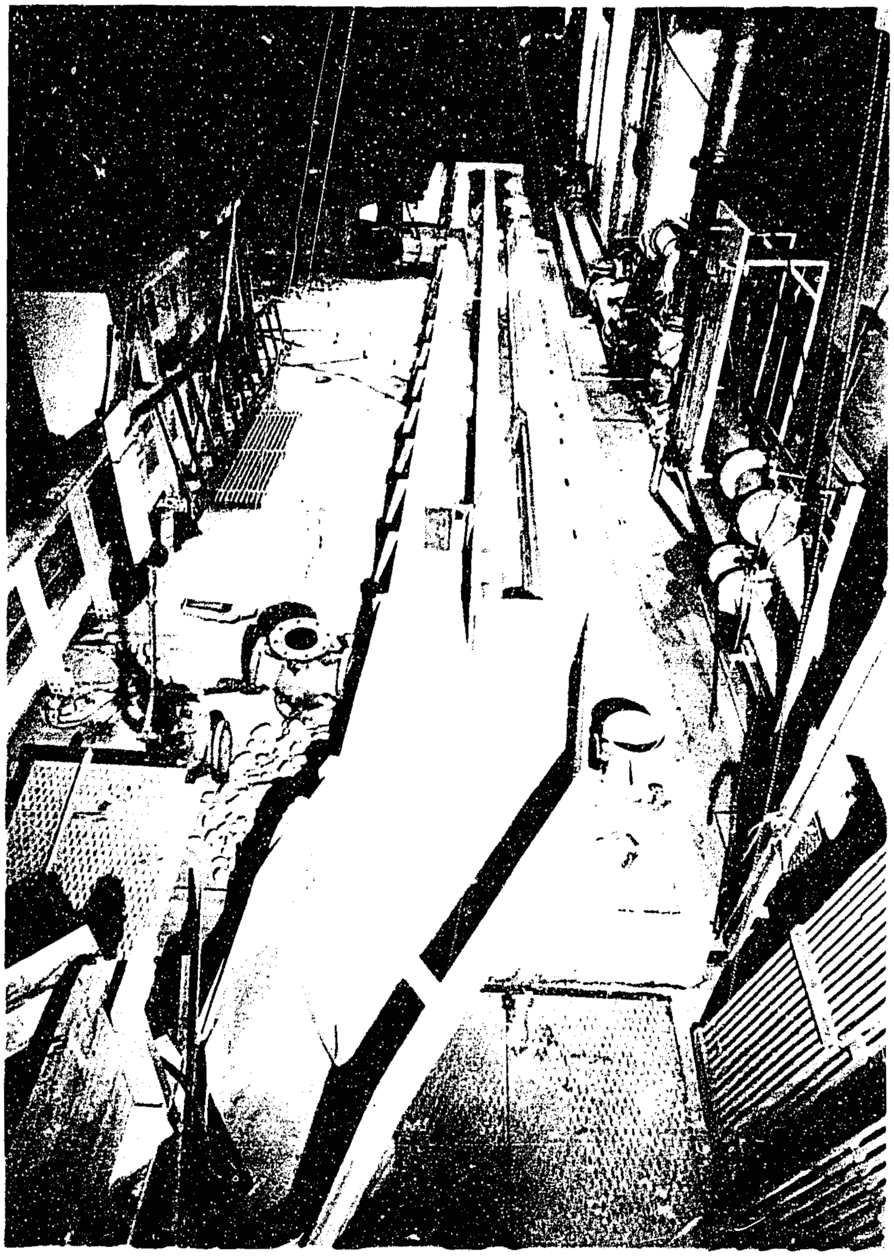
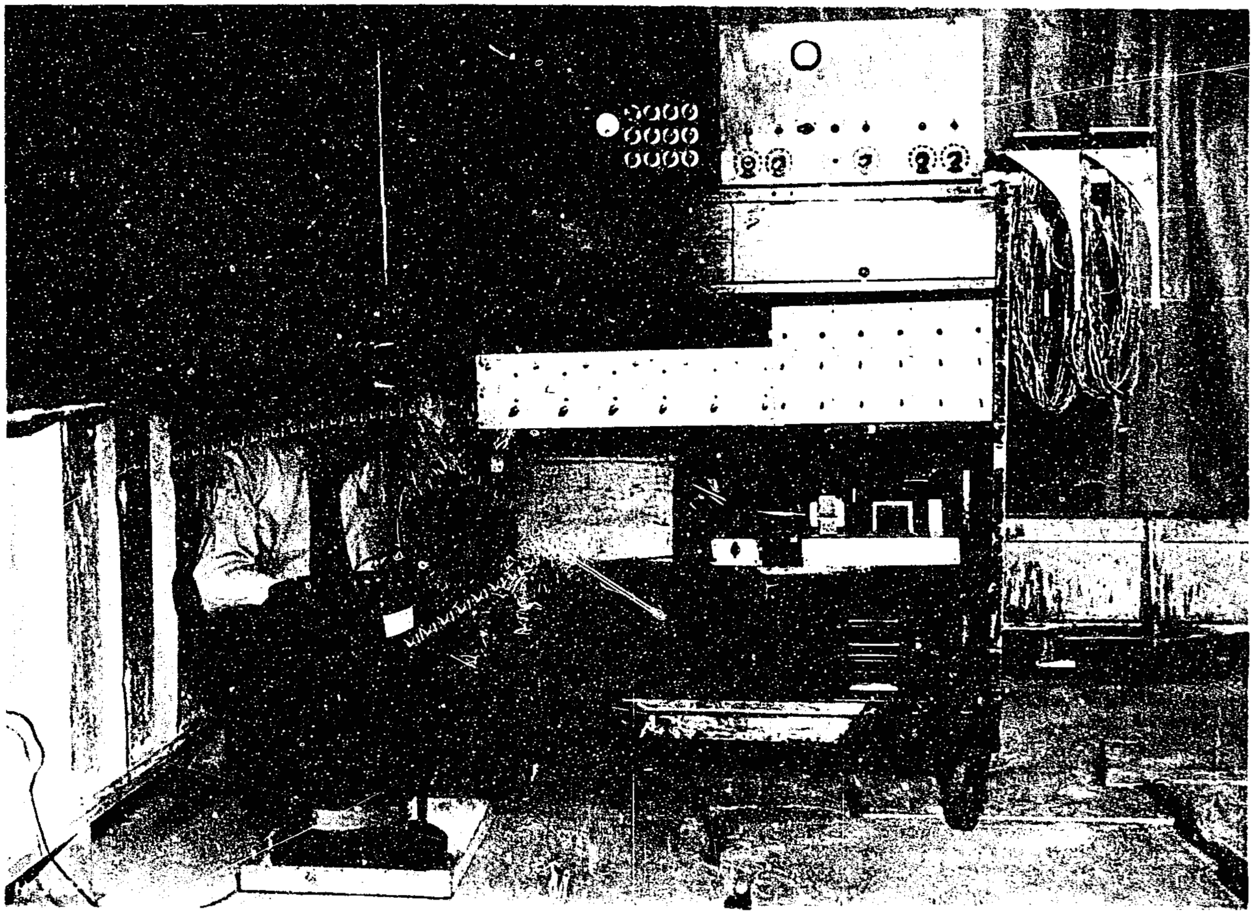
FIGURE 1



Overall view of model showing location of roughness, flood generator, and sections 1 and 2 and A and B.

COACHELLA PROTECTIVE WORKS

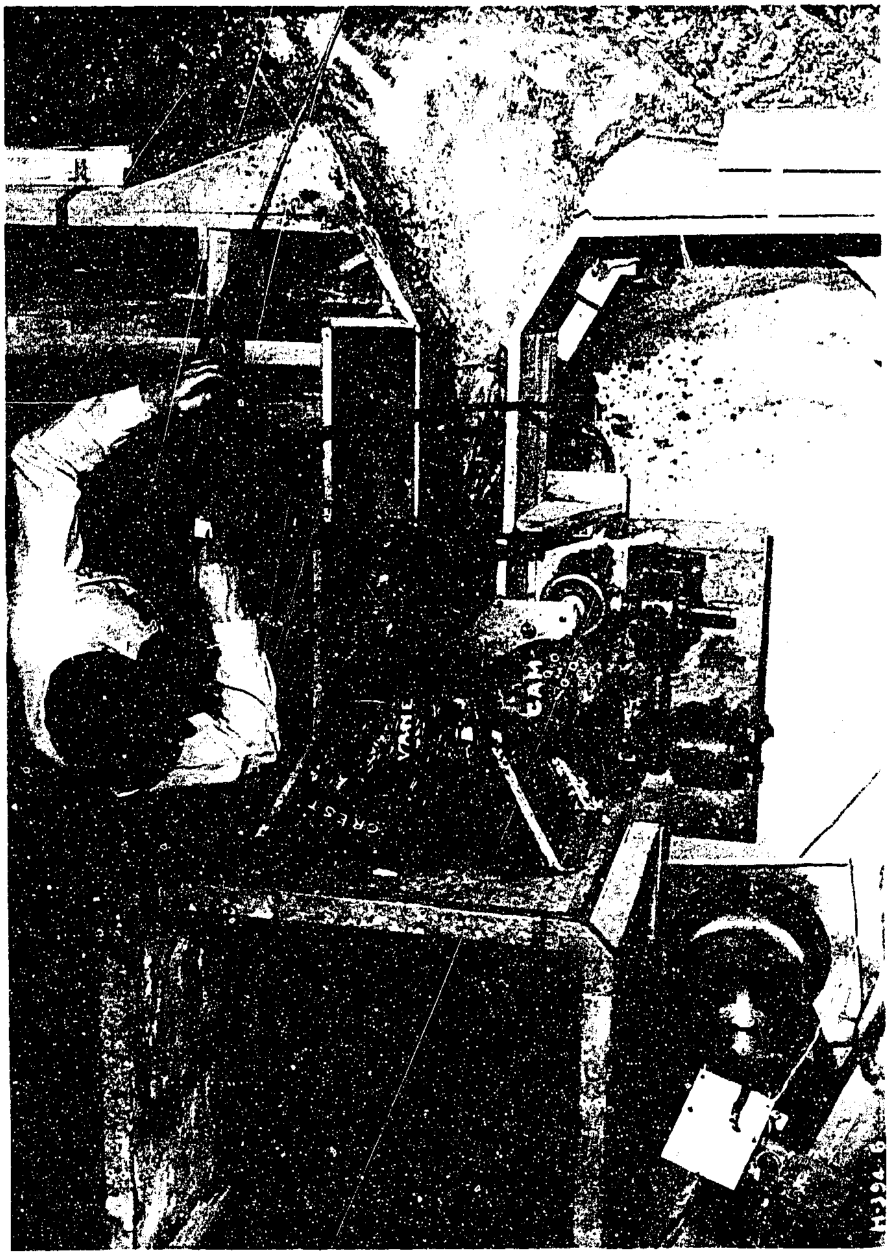
FIGURE 2



Detail of electronic equipment for measuring depths - one electrode in place for calibration.

COACHELLA PROTECTIVE WORKS

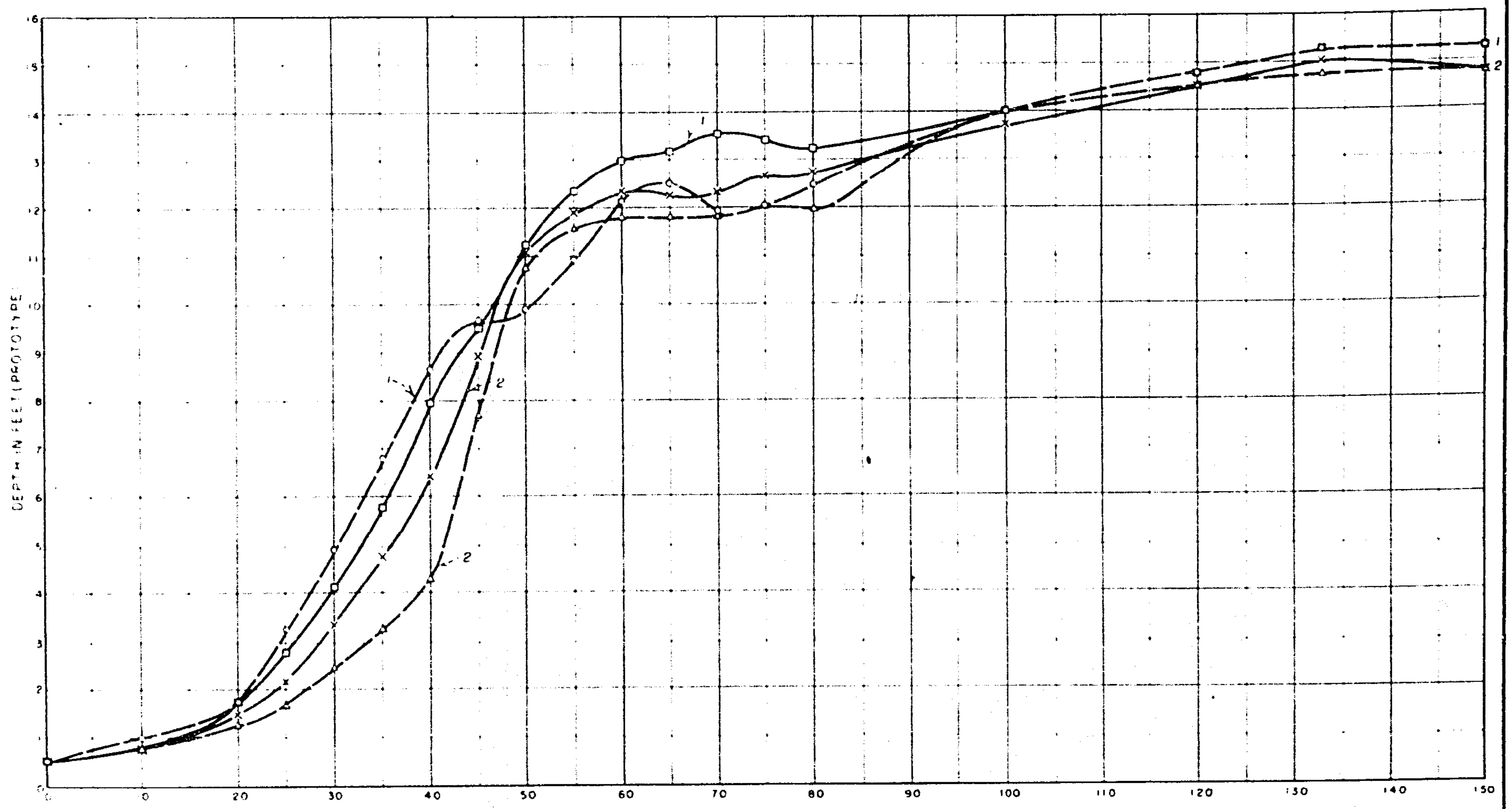
FIGURE 3



Detail of flood generator

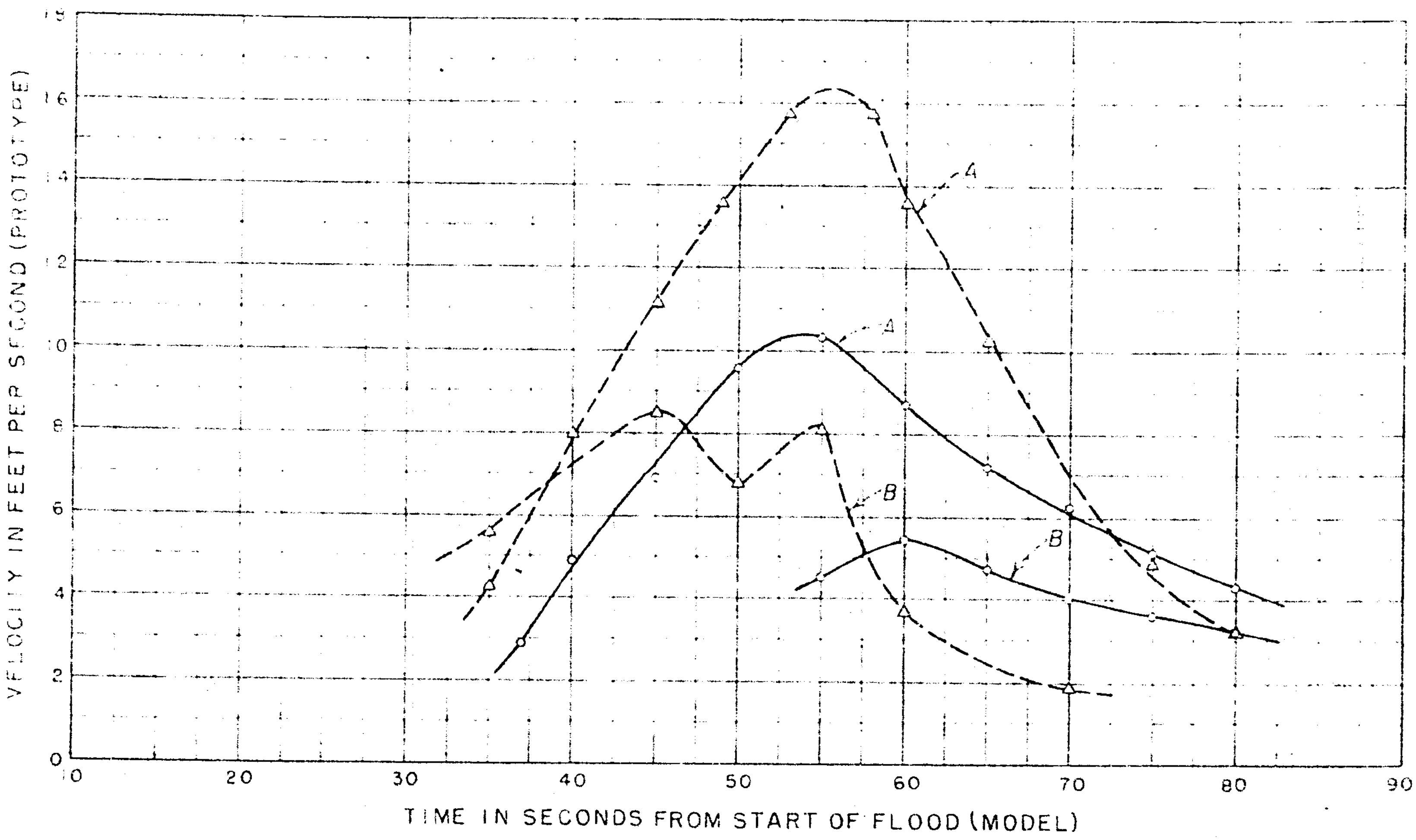
COACHELLA PROTECTIVE WORKS

FIGURE 4

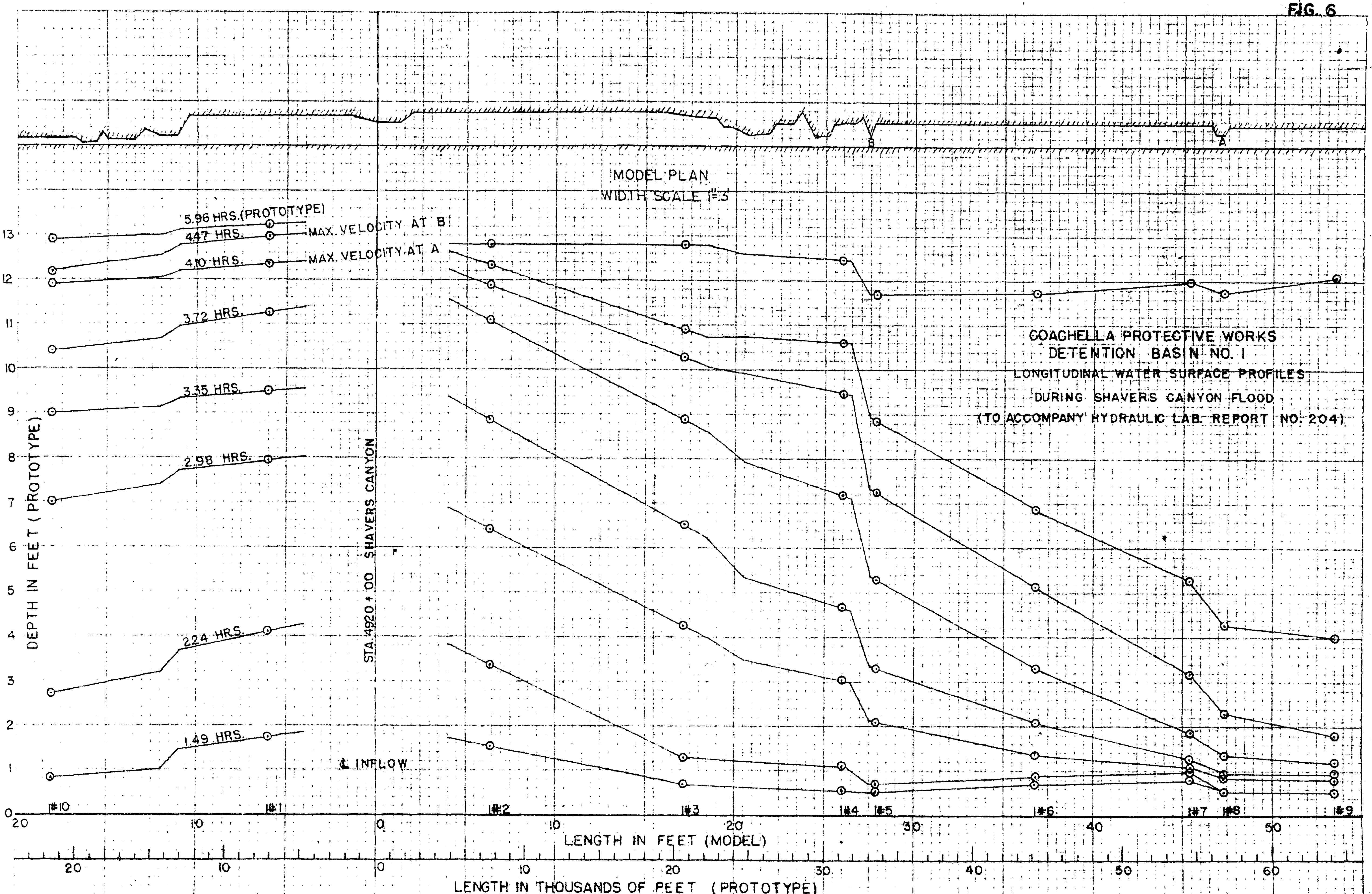


COACHELLA PROTECTIVE WORKS-DETENSION BASIN No. 1
VARIATION IN DEPTH DUE TO SHAVERS CANYON FLOOD
—— With added roughness
– – – No added roughness

FIGURE 5



COACHELLA PROTECTIVE WORKS-DETENSION BASIN No. 1
VARIATION IN VELOCITY AT CRITICAL SECTIONS A AND B
——— With added roughness ‑‑‑‑ No added roughness



COACHELLA PROTECTIVE WORKS
DETENTION BASIN NO. 1
LONGITUDINAL WATER SURFACE PROFILES
DURING SHAVERS CANYON FLOOD
(TO ACCOMPANY HYDRAULIC LAB. REPORT NO. 204)